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USNFMSO ltr, 10 Nov 1977

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NETWORK ANALYSIS CORPORATION

Beechwood, Old Terport Road, Glen Cove, N. Y. 11542 / 516 671-9580

CATALOG NUMBER: WM.060.01

WORKING MEMORANDUM

AUTHOR: P. V. McGregor

DATE: May 15, 1975

SUBJECT: Preliminary System description for Navy LDCN FEP  
Feasibility Study

ABSTRACT This memorandum presents a preliminary description of the system environment for a Front End Processor in the Navy Logistics Data Communications Network. The description should serve as a framework for refinement into a detailed description on which the feasibility study can be based.

WORKING MEMORANDUM  
FOR THE DIRECTOR, NAVY LOGISTICS CENTER  
NAVY LOGISTICS CENTER, GAITHERSBURG, MARYLAND  
11542-1000  
COMMUNICATIONS SECTION  
NAVY LOGISTICS CENTER

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13. ABSTRACT These documents describe the physical environment in which the Front End Processors for the Navy Logistics Data Communications Network, must operate. These descriptions serve as a framework for refinement upon which a feasibility study can be based. It defines things such as functions, traffic and Interfaces it must support. These reports will also be used to identify a least cost configuration for the system that will still satisfy its requirements.			

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Data Processing  
Naval Supply Systems  
Dept. of Navy  
Washington, D. C. 20376

The Navy Fleet Material Support Office (FMSO) is currently evolving an integrated, real-time data communications network to provide a large number of dispersed Navy sites with logistics information necessary for effective and efficient logistics support. The Logistics Data Communications Network (LDCN) will enable remote sites to directly access major logistics data bases at two Inventory Control Points (ICP's). Programmable communications concentrators at selected remote sites will be used for cost-effective interface of low speed terminals with the computer complexes managing the data bases. These complexes each have two U494 computers, and one also has an IBM 360/65, and the other also has a Burroughs 3500.

FMSO has identified the need for a Front End Processor (FEP) at each of these complexes to serve the communications functions for the main computers. However, the size, power, and configuration of the computer system needed for the FEP is not clear. Of particular interest in this respect is the feasibility of using a minicomputer system to support the traffic and functions envisioned for the FEP. The purpose of this study is to determine this feasibility; and, if the feasibility is affirmative, to identify a least cost configuration for the minicomputer system that will satisfy the FEP requirements.

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The viability of a minicomputer system as an FEP in the LDCN will depend on many factors, including the functions associated with the FEP, the traffic it must support, and its interfaces with other system elements. This memorandum gives a preliminary description of the network environment in which the FEP will operate, the functions associated with the FEP, the traffic it must support, and a proposed FEP configuration for use in resolving the feasibility question. The information presented here was largely developed by FMSO personnel to assist describing the baseline system for the study.

## 2. NETWORK CONFIGURATION

FMSO manages major logistics data bases at two ICP's; one at the Ship Parts Control Center (SPCC) at Mechanicsburg, Pa., and the other at the Aviation Supply Office (ASO) at Philadelphia, Pa. The SPCC computer complex contains two U494 computers and an IBM 360/65. The ASO computer complex contains two U494 computers and a Burroughs 3500. At each ICP, one U494 supports real time processing activity for an Inventory Control (IC) data base, and the other U494 supports real time processing for a Weapons System (WS) data base. At both locations, each U494 can access the other's data base in a read only mode. The IBM 360/65 maintains a Material Maintenance Management (3M) data base, and the B3500 is used to track progress of high priority stock transactions for air logistics support.

Approximately 775 terminals will access the data bases through nine programmable communications processors used as concentrators. Two of the nine concentrators will be located at SPCC for local terminal access, and, similarly, two will be located at ASO. The remaining five concentrators will be located in Washington, D.C., San Diego, Calif., Oakland, Calif., Jacksonville, Fla., and Norfolk, Va. The tentative network architecture calls for each of the concentrators to be dual-homed to the two ICP's. An estimate of the terminal distribution by location and category is given in Table 1.

The FEP's will serve to interface the main computers at the ICP with the remote concentrators. The concentrator-FEP connections are tentatively planned to be through dedicated 9600 bps circuits. The FEP-main computer connections are also tentatively planned to be through dedicated 9600 bps circuits, although other alternatives, such as main computer channel access, are currently being considered. The FEP's will also be used to interface with the AUTODIN CDC-1700 interface terminals, one interface at each ICP. The interface will be through dedicated 1200 bps or 2400 bps circuits.

The overall network configuration is shown in Figure 1.

### 3. SYSTEM OPERATION

The system operation is transaction oriented, with two basic types of transactions: upquiries to update the data base, and inquiries to extract information from the data base. The transactions may also be divided into those requiring real-time processing and those which may be grouped for batch processing. For convenience, we will identify those requiring real-time processing as RTT's (Real-Time Transactions) and those which may be grouped for batch processing as PBT's (Possibly-Batched Transactions). PBT's are batched according to application programs, with a processing schedule based on batch size, waiting time, and absolute time.

Not so! Both RTT's and PBT's may enter the system through interactive terminals. Remote Job Entry (RJE) terminals and the AUTODIN interface are assumed to enter only PBT's. The system operation is described below in terms of these three methods of transaction entry and the handling of batched transactions.

#### 3.1 Interactive Terminals

The system operation is best described in terms of the user activities at the terminal. The initiation of an upquiry or inquiry first requires establishment of communications with the system. The terminal operator does this by initiating a request for service by typing the North Arrow (↑) character. This signals the concentrator that a new activity is to be commenced, and the concentrator signifies its ready status by return of a date and time response. The operator then enters the program type information necessary for the concentrator to verify that the system will support the indicated activity. An affirmative response then allows the terminal operator to enter the appropriate data. When this activity is complete, the concentrator has within it the transaction (upquiry or inquiry) for transfer to the appropriate FEP.

The concentrator then adds an appropriate routing header to the transaction, and queues the transaction with other transactions from the other terminals, for transfer to the appropriate FEP.

After transfer of the transaction to the FEP is complete, the FEP examines the transaction, and if the transaction is identified as an RTT, it is <sup>IMMEDIATE</sup> immediately placed on queue for transfer to the appropriate main computer. If the transaction is identified as a PBT it is placed on the appropriate application queue, and will remain there until the application batch is to be processed.

Processing of transactions by the main computer results in outputs to be returned to the user. These outputs are immediately transferred from the main computers to the FEP where they are then processed to determine appropriate routing, and queued for transfer to the appropriate concentrator.

The current design of the concentrator does not use auxiliary storage for buffering. Consequently, the FEP must queue the output until the concentrator has sufficient buffering available for the first part of the output to be delivered to the terminal. Once transfer of the output from the FEP is initiated, the concentrator continuously delivers the output to the terminal, using double buffering to enable request of each new part of output from the FEP without interrupt of transmission to the terminal. The life cycle of the transaction is complete when the last character of the output is delivered to the terminal.

There may be considerable time between the completion of transaction input and return of the output. During this time, the operator may initiate input of another transaction. If this is done, transmission of an output to the terminal must wait for completion of the input process.

### 3.2 Remote Job Entry

Several RJE terminals (card readers plus line printers) will be connected to the concentrators to facilitate entry of batched transactions. In this mode of operation, each transaction will be on one card. The concentrator will simply receive the transactions, determine the FEP to which they are to be forwarded, and place them on the appropriate queue for transmission to the FEP. Because the concentrator does not have auxiliary storage buffering, provision must be made for the concentrator to control the RJE input on the basis of buffer availability, or for the RJE transactions to have sufficient priority to ensure that their transmission to the FEP is consistently faster than their input to the concentrator.

Once the RJE transactions reach the FEP, they are processed as ordinary PBT's. This processing will be described in Section 3.4. Note that it is assumed that no transactions entered by RJE will be identified as RTT's.

### 3.3 AUTODIN Entry

The FEP will receive transactions through the AUTODIN interface. These transactions will basically be handled by the FEP in the same manner as transactions received from RJE terminals through the concentrator. However, additional routing and AUTODIN protocol processing will be necessary.

### 3.4 FEP Operation

The FEP will receive transactions from the AUTODIN interface and from the concentrators. As the transactions are received, they

are identified as RTT's or PBT's. RTT's are immediately placed on queue for transfer to the appropriate main computer. PBT's are placed on the appropriate application queues.

Each application queue will be a batch for processing by the appropriate main computer. Each batch will have a processing schedule that may be based on batch size, waiting time, or periodic processing. Examples of such rules are:

1. Process every three hours or whenever the batch reaches fifty transactions.
2. Process whenever the batch reaches twenty transactions or whenever the longest waiting transaction has waited six hours.
3. Process at 8:00 P.M.

When a transaction entered through a concentrator is processed by a main computer, an output is generated for retransmission to the user. This output is immediately transferred to the FEP. If the transaction was an RTT, the output is immediately queued for transfer to the appropriate concentrator. The transfer will be effected as described earlier.

If the transaction is a PBT, the output will be destined for a line printer. The outputs are queued on the basis of destination until the batch processing is complete. The outputs destined for

line printers will then be transferred to the appropriate concentrators with the same double buffering technique described earlier for RTT's.

Not all transactions arriving over the AUTODIN will generate outputs. The outputs that are generated will be immediately transferred to the FEP where they will be queued until a full AUTODIN message is formed or until the batch processing is complete. The FEP processes the outputs to place them in proper AUTODIN message format, and then transfers the message to the AUTODIN host processor. This process will continue until all outputs have been transferred.

#### 4. FEP FUNCTIONAL DESCRIPTION

The functional description of the FEP provided by FMSO is intended to be as machine independent as possible. The description is in terms of functional software modules organized for processing transactions moving upstream in the system and outputs moving downstream. The modules may be viewed as application programs that must be properly coordinated by an FEP executive.

The description is intended to serve as a basis for developing the FEP software. The implementation of the FEP should be guided by the objective of minimal reprogramming of the concentrators and main computers. Because the DCT 1000 protocol is currently used for the main computer/concentrator interconnection, this objective suggests use of the DCT 1000 protocol for main computer/FEP interconnection and for the FEP concentrator interconnection. However, if other alternatives, such as the Digital Data Communications Message Protocol (DDCMP) or direct channel access, show significant advantage with small reprogramming requirements, they may be used.

A brief description of the functional processing to be performed by the FEP is as follows:

1. Receive messages from AUTODIN host processors and remote concentrators.
2. Create a stub for transactions containing:
  - a. Date and time stamp.
  - b. Input routing indicator.
  - c. Output routing indicator.
  - d. Internal routing indicators.
  - e. Transaction identifier.

3. Process transactions according to internal routing indicators.
4. Queue transactions for input to the host (either immediate or based on time and/or volume).
5. Schedule input to the host.
6. Dequeue transaction for delivery to host.
7. Transmit transaction to the host.
8. Queue transaction output from host.
9. Schedule output to concentrators and Autodin.
10. Transmit messages to concentrators.
11. Create Autodin messages.
12. Transmit Autodin messages to Autodin interface terminal.

The software module organization identified for this processing is shown in Figure 2. These modules are briefly described below.

#### 4.1 Autodin Interface Module

The AUTODIN interface module will receive transactions from the AUTODIN CDC 1700 interface terminal processor. The protocol for this interface is not yet defined. After transmission error checking is complete, a transaction stub will be created indicating date and time that the transaction was received from AUTODIN. The transaction is then forwarded to the Input Recognition module.

The output function of the AUTODIN interface module will be to receive line blocks from the AUTODIN Message Compiler module, and

transfer them to the AUTODIN CDC 1700 interface terminal processor.

#### 4.2 Concentrator Interface Module

The Concentrator Interface module will allow communication between the front-end and the concentrators. It is assumed that all of the concentrators will make use of the same software package; therefore, only one line protocol technique will be required in the front-end.

The Concentrator Interface module will receive terminal transactions from the concentrators. After transmission error checking is complete, the user's identification code will be checked against a table containing all valid user's of the system at that location. If the user is valid, a transaction stub will be created indicating date and time, the input routing indicator and the output routing indicator. If only an input routing indicator is present in the transaction it will also be used as the output routing indicator. If the user is not a valid user the transaction will be returned to the input routing indicator with an error message indicating the error and processing of the transaction will terminate.

The transaction with its stub is then forwarded to the Input Recognition module.

The output portion of the module will receive output terminal messages from the Queue/Dequeue module. After blocking message into the transmission blocks, it sends the blocks to the concentrator. Output messages that created multiple transmission blocks are to be interleaved with other traffic to the same concentrator.

#### 4.3 Host Interface Module

The Host Interface module will have the responsibility of the communications between the FEP and the host computers (main computers). If possible, a common interface protocol is to be used for all hosts,

with the protocol for DCT 1000 terminals the tentatively planned protocol because of its current support in the U494 processors.

The Host Interface module will receive transactions from the Queue/Dequeue module and forward them to the proper host for processing. Output from the host will be forwarded to the Queue/Dequeue module.

#### 4.4. Input Recognition Module

The Input Recognition module will receive all transactions from both the Concentrator Interface module and the AUTODIN Interface module. All transactions received via AUTODIN will have the transaction ID added to the transaction stub and then forwarded to the Queue/Dequeue module.

Transactions received via the concentrators will be formatted to conform to one of the standard transaction formats. After the transaction is in the proper format, the type of the transaction will be determined, i.e., upquiry or inquiry, and the data base to be affected. This information is compared to a set of tables to determine if the user is authorized to complete the function requested. If not, the transaction is returned to the input routing indicator with an indication of the error and processing is terminated.

If the user is authorized to complete the function, the internal routing indicator is appended to the stub and the transaction is sent to the Queue/Dequeue module.

#### 4.5 Queue/Dequeue Module

The Queue/Dequeue module manages the transaction queues. All transactions inputted to or outputted from the FEP are recorded in mass storage files. RTT's will be recorded in a file and sent to the appropriate host at the same time. PBT's will be recorded in queues

20 1 queue table  
1 of each type trans in it

for later processing as directed by the time and/or volume criteria established by the unit. A queue table<sup>per type</sup> will be maintained for each type. Each entry will contain the first record to be processed from the queue and the total number of entries in the queue.

The mass storage will also be used to buffer, queue, and file output messages from the host. Only a single storage allocation should be required to serve all three of these storage functions. A copy of the queue tables will also be maintained on the mass storage.

#### 4.6 Scheduler Module

The Scheduler module will constantly monitor the queue table to insure that all transactions are processed according to the scheduling criteria established by the unit. All scheduling criteria will be contained in tables which specify the transaction type, input routing indicator and time and/or volume information. The Scheduler module upon detecting a queue to be processed will send a request to the Queue/Dequeue module containing the queue to be processed and the destination of the contents.

#### 4.7 AUTODIN Message Compiler Module

The Autodin Message Compiler module will receive transactions from the Queue/Dequeue module as directed by the Scheduler module. A standard AUTODIN header with routing address will be appended to the front of the AUTODIN message. When a predetermined number, set by the unit, of transactions have been sent to the AUTODIN Interface module, a AUTODIN trailer will be appended to the end of the AUTODIN message. The AUTODIN Message Compiler will repeat the process until the queue is empty. The predetermined number of transactions is an upper limit; provisions will be made to send fewer transactions when required.

5. TRAFFIC

Transactions arrive at the FEP through either the AUTODIN interface or the concentrator interfaces. All entry mechanisms may be used for both inquiries and upquiries. Although the precise mix of traffic is not known, it is known that inquiries are much more frequent than upquiries. Consequently, it will be assumed that 80% of the traffic from any source will be inquiries, and 20% upquiries.

Transactions arriving through the AUTODIN interface are PBT's, and have constant 80 column card image size. AUTODIN upquiries do not result in an output.

AUTODIN inquiries result in outputs that are also constant 80 column card image size.

Transactions arriving through the concentrator interfaces may have originated at RJE terminals or interactive terminals. Transactions originating at RJE terminals have an average input length of 100 characters, with an assumed uniform distribution from 50 to 150 characters. Outputs generated by upquiries simply echo the inputs, while outputs generated by inquiries have an average message length of 2000 characters, assumed uniformly distributed from 1000 to 3000 characters.

Transactions originating at interactive terminals may be either PBT's or RTT's, and have a length of approximately 50 characters average, with an assumed uniform distribution from 40 to 60 characters. As before, upquiries result in outputs that are simply an echo of the inputs. Inquiries result in outputs that have an average length of 520 characters, with an assumed uniform distribution from 220 characters to 820 characters.

The nominal demand placed on the system is based on the following activity levels for the different entry mechanisms:

1. Teletypes (110bps) enter 20 transactions per hour.
2. CRT's (1200bps) enter 35 transactions per hour.
3. RJE's (4800bps) enter 15 transactions per hour.
4. <sup>(2, 20, 20, 20)</sup> AUTODIN enters 50,000 transactions per day, of which  
20%, 30%, 40% and 50% are to be investigated as peak hour  
factors.

used {

An indication of local terminal response time is to be determined for 30%, 40%, 50%, 60%, and 70% of the interactive terminal transactions being RTT's.

Approximately 90% of the traffic entered through the four local concentrators of the ICP's will go to their respective ICP processor with the remaining 10% directed to the processors at the other ICP. The traffic from the five remote concentrators will have approximate 56% of the transactions directed to ASO and 44% to SPCC.

Approximately 56% of the traffic into the SPCC main computers will be directed to the ICS machine, 35% to the WEPS machine, and 9% to the 3M machine. Traffic into the ASO machine is currently averaged 71% to the ICS machine, 29% to the WEPS machine, with the B3500 yet to be integrated into the on-line operations.

6. PROPOSED FEP SYSTEM CONFIGURATION

To determine the feasibility of using a minicomputer-based system for the FEP, a PDP 11 configuration has been proposed as a baseline system for investigation. The configuration is based on dual PDP 11/70 CPU's sharing dual ported disks and line controllers to operate in a load sharing or hot standby mode. For purposes of evaluation, a hot standby mode will be assumed.

The system configuration is graphically portrayed in Figure 3, and contains the following hardware elements:

1. Two PDP 11/70 CPU's with 2K byte cache memory, 128K byte core, line frequency clock, DECwriter and interface,
2. Two (2) TWU16-EA program selectable 1600/800 bpi magnetic tape transports and control units (nine track industry compatible, 45 ips),
3. Two (2) RWPO4-BA 88 million byte disk drives with dual access, and two (2) PDP 11/70 control units,
4. One (1) DV11-AA synchronous communication multiplexer with two (2) DV11-BA eight-line termination units and provision for dual processor control.

For total redundancy, an extra communications multiplexer should be available. However, there does not appear to be available standard DEC hardware for online redundancy of this component.

Standard DEC operating systems, such as the RSX-11M, and communications software modules, such as in COMTEX, are envisioned for the basic system software. The functional modules defined in Section 4 would be developed as application tasks.

The proposed configuration described above is based on a communications interface with the main computers. It may be more appropriate to use a direct channel interface with the FEP emulating a standard channel device of the main computers. This type of interface appears feasible for the PDP-11 system, but not available as a standard DEC product.

7. CONCLUSION

This memorandum has presented a preliminary description of the system environment for a Front End Processor in the Navy Logistics Data Communications Network. The description should serve as a framework for refinement into a detailed description on which the feasibility study can be based.

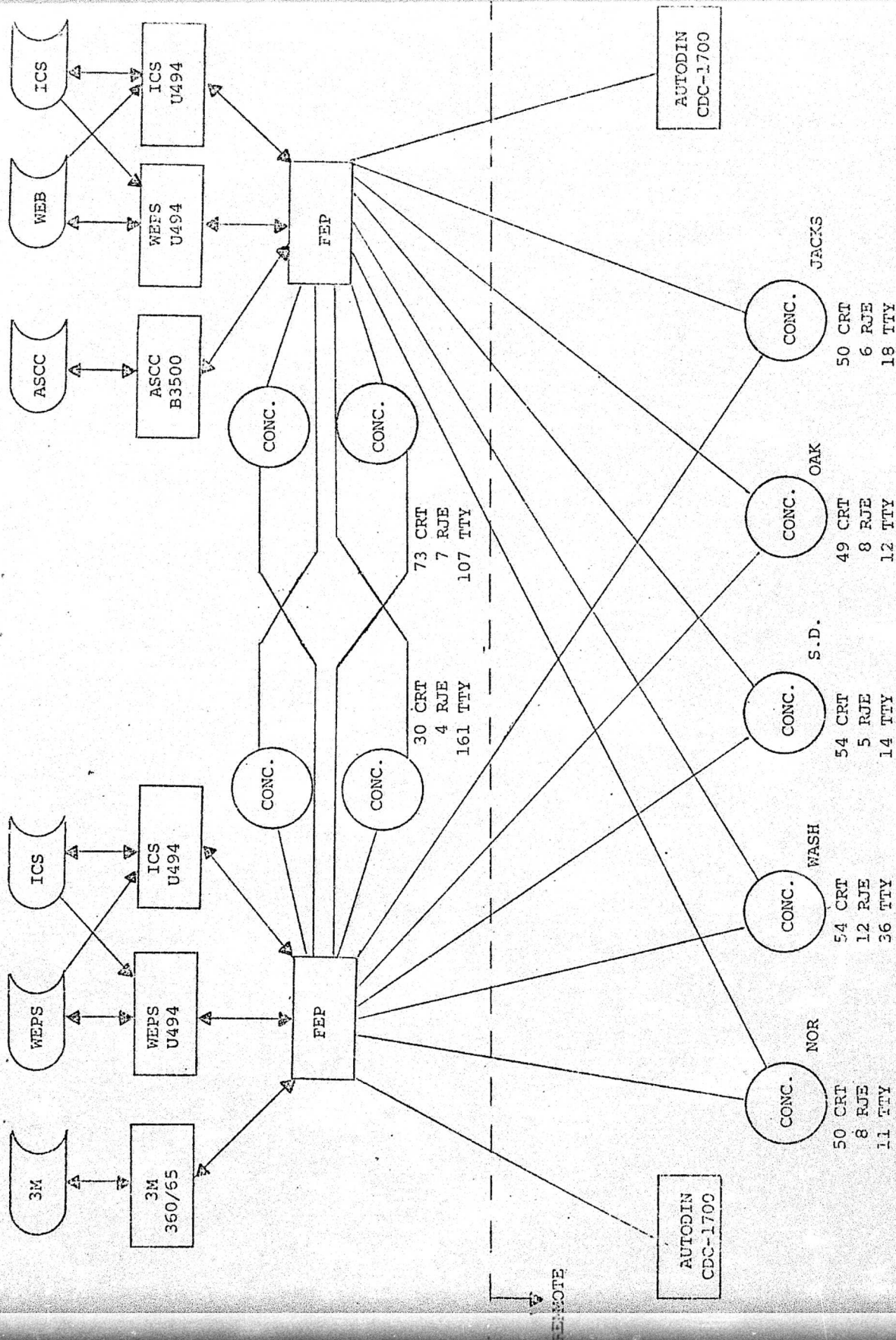


FIGURE 1: OVERALL NETWORK CONFIGURATION

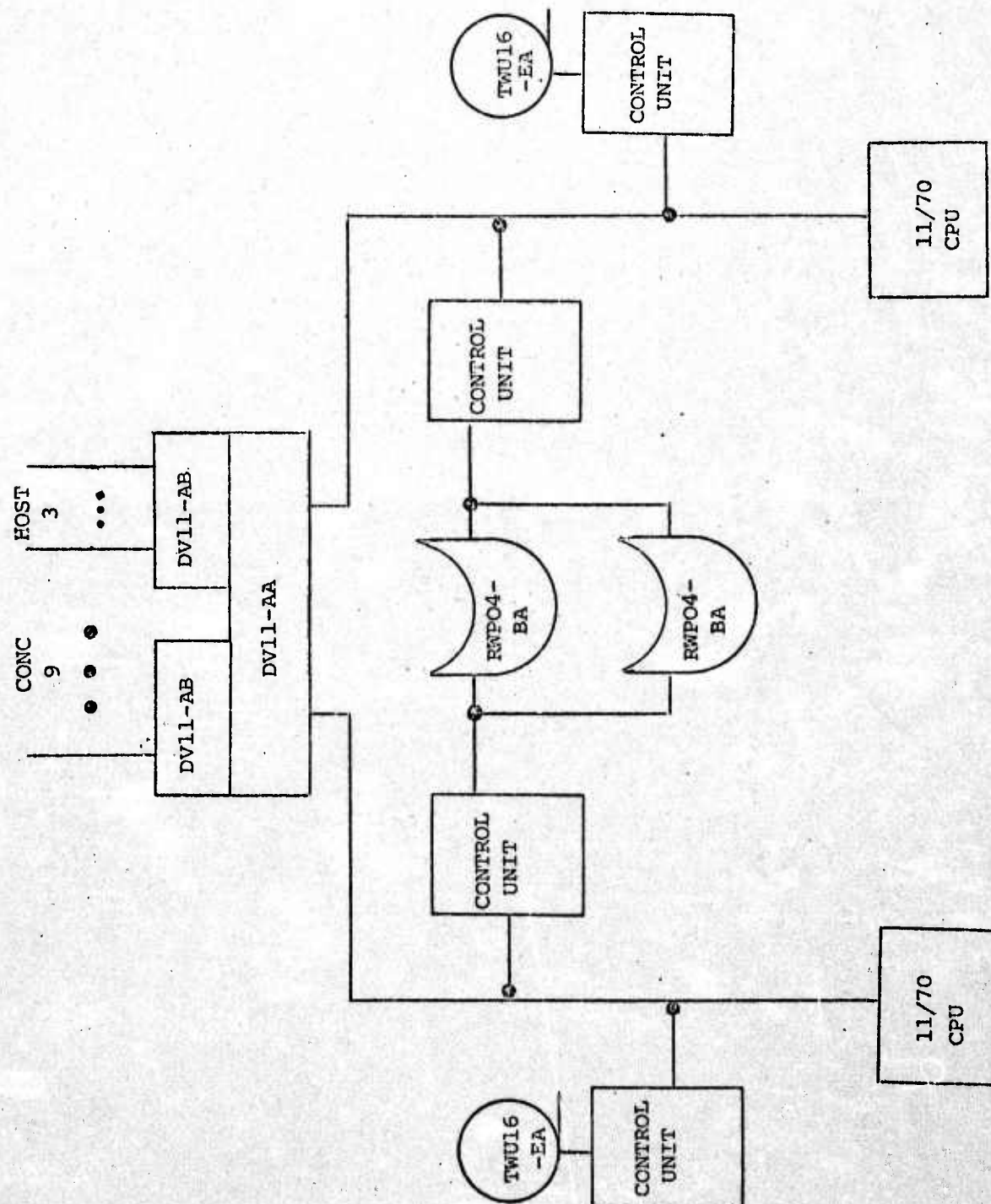


FIGURE 3: A PROPOSED FEP HARDWARE CONFIGURATION

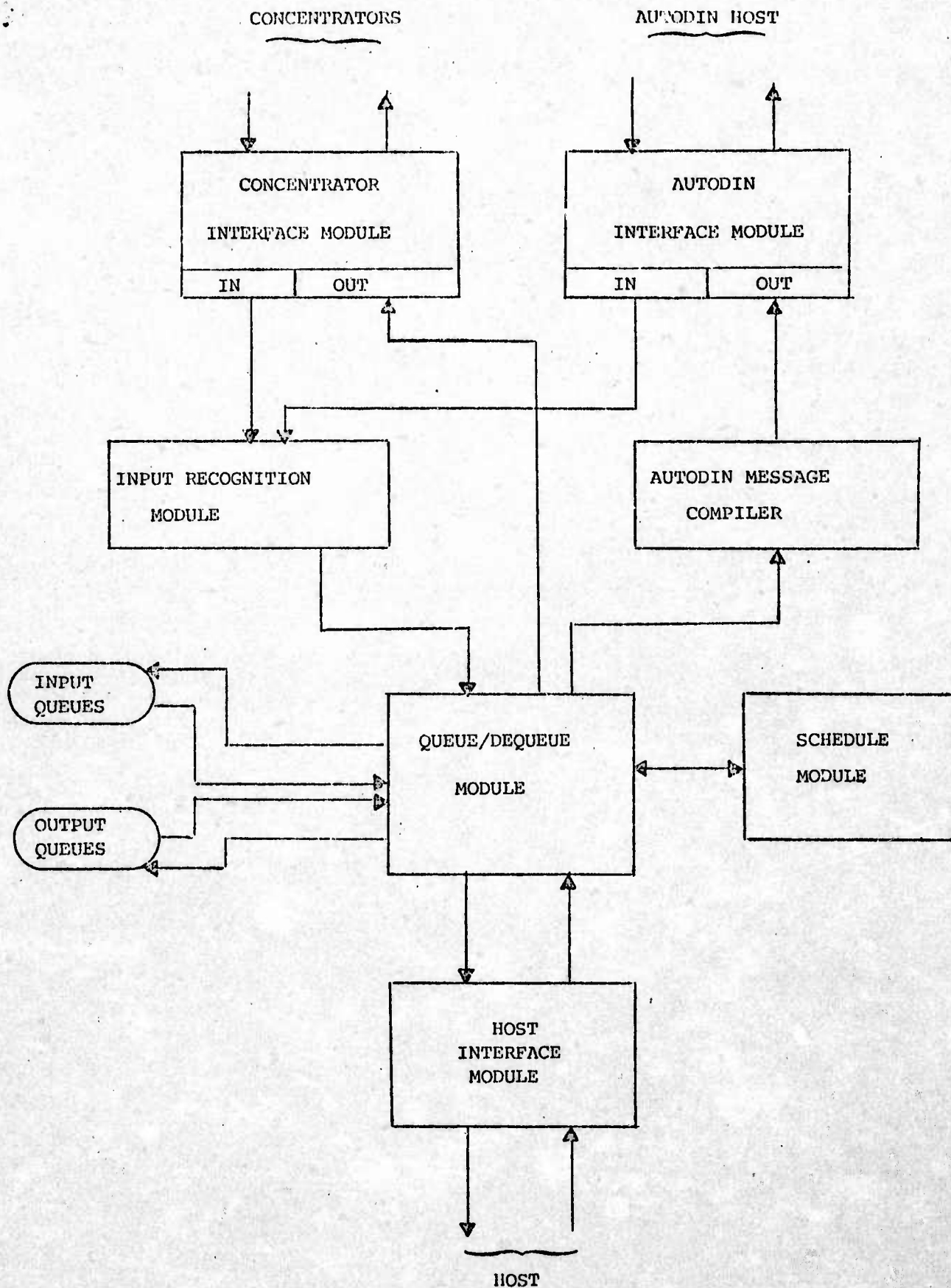


FIGURE 2: FEP SOFTWARE ORGANIZATION

LOGISTICS DATA COMMUNICATIONS9 REMOTE CONCENTRATORS AND 775 TERMINAL LOCATIONS

(PROPOSED)

PHASE IITERMINAL SPEEDS  
(BAUDS)

<u>LOCATION</u>	<u>CRT</u>	<u>RJE</u>	<u>TTY</u>
	300<X≤2400	2400<X≤9600	X≤300
	(X = Baud Rate)		
<u>NORFOLK, VA</u>			
NSC NORVA	2		
NAS NORVA	2		
NARF NORVA	2	1	1
AIRLANT/AMO	2		
REPLANT	4	2	1
NSY NORVA	2		
SAFETY CENTER	1		
NAVSEC NORDIV	3	1	
NOSSOLANT	2		
NAILSC	2	1	
NMCF YORKTOWN	1		
SERVLANT	2		
NAS PAX	2		1
NAS OCEANA	1		1
PHIBLANT	2		
FOSATLANT	1	1	
<u>WASH, DC</u>			
NAVSEC, ANNAPOLIS	2		
NAVORD	3	1	2
NAVSEA	4	2	4
NAVELEX	10	2	10
NAVSEC	6	2	9
NAVAIR	5	2	3
CNO	3	1	
CENO, III	3	1	2

TABLE I: TERMINAL DISTRIBUTION

ASO

NAVELEX PORTS	2		1
PERA ASW	2	1	
PERA SS	2	1	
PERA AAW	2	1	
ASO	30	2	100
NAEC	2	1	
NATSF	2		
NSY PHILA	2		
NAVSEC PHILA	3		
NSY PORTS	2		
NAS BRUNSWICK	1		
CEC DAVISVILLE	1		
NUSU NPT	2		
SUBLON	1		
NAS LAKEHURST	1		

SPCC

SPCC		2	150
NAVSEC, MECH		1	4
NAVILCO	2		1
MSO	7		
PWC GREAT LAKES	1		
NAFI	2		

SAN DIEGO

NSY LBEACH	2		
NSC SD	2		
NAS NORIS	2		
NARF NORIS	2	1	1
REPAC	4	2	1
MSDO	2		
AIRPAC/AMO	3		1
NAVSEC WEST	4	1	1
NOSSOPAC	2		
NAVELEX, SD	4		1
EL TORO	2		1
NAS MIRAMAR	2		1
NSC PEARL	2		
PHIBPAC	2		

OAKLAND

NSMSES	2		
FMSAEG, CORONA	1	1	
NAVELEX, OAK	2		1
NSY HARE IS	2		
NARF ALAMEDA	2	1	1
NAS ALAMEDA	2		1
NSC OAKLAND	2		
NWS CONCORD	2	1	
NSY PUGET	2		
NSC PUGET	2		
PT MUGU	2	1	
PT HUENEME	2	1	1
NAS MOFFETT	2		1
NAS WHIDBEY	2		1
CHINA LAKE	2		
PERA CV	2	1	

JACKSONVILLE

NAVELEX, CHARLESTON	2	1	
NAS PENS LOLA	2		1
NARF PENSACOLA	2	1	1
NAS JACKSONVILLE	2		1
NARF JACKSONVILLE	2	1	1
NSC CHARLESTON	2		
MCAS CHERRY POINT	2		2
NARF CHERRY POINT	2	1	1
NOS LOUISVILLE	2		
NAS CECIL	2		1
NAS ALBANY	1		
NAS MAYPORT	1		
NAS CORPUS	1		1
CNATRA	2		1
CNET	2		1
NAS MEMPHIS	1		
NAS KEY WEST	2		1
NTC ORLANDO	1		
CBC GULFPORT	1		

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